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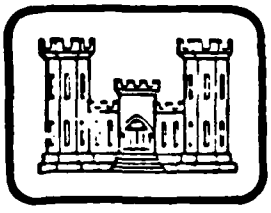

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METHODS FOR DETERMINING NONMERCHANTABLE FOREST BIOMASS YIELDS FOR USE AS FUEL

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19 July 1980

FINAL REPORT

Prepared for:
US Army Facilities Engineering Support Agency
Technology Support Division
Fort Belvoir, VA 22060

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Final rept.

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: FESA-TS-2089	2. GOVT ACCESSION NO.: AD-A100831
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): METHODS FOR DETERMINING NONMERCHANTABLE FOREST BIOMASS YIELDS FOR USE AS FUEL	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Stephen C. Forget, CPT, USAR, EN	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: US Army Facilities Engineering Support Agency, Technology Support Division, Fort Belvoir, VA 22060	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 11
11. CONTROLLING OFFICE NAME AND ADDRESS: 12	12. REPORT DATE: 19 Jul 1980
	13. NUMBER OF PAGES: 10
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Forest Biomass, Nonmerchantable, Linear Regression, Yield Tables

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is intended to provide the reader with a brief overview of state-of-the-art methods for determining nonmerchantable forest biomass yields, with emphasis on the Southeastern United States. Detailed information/ methodologies for specific needs may be found in the references.

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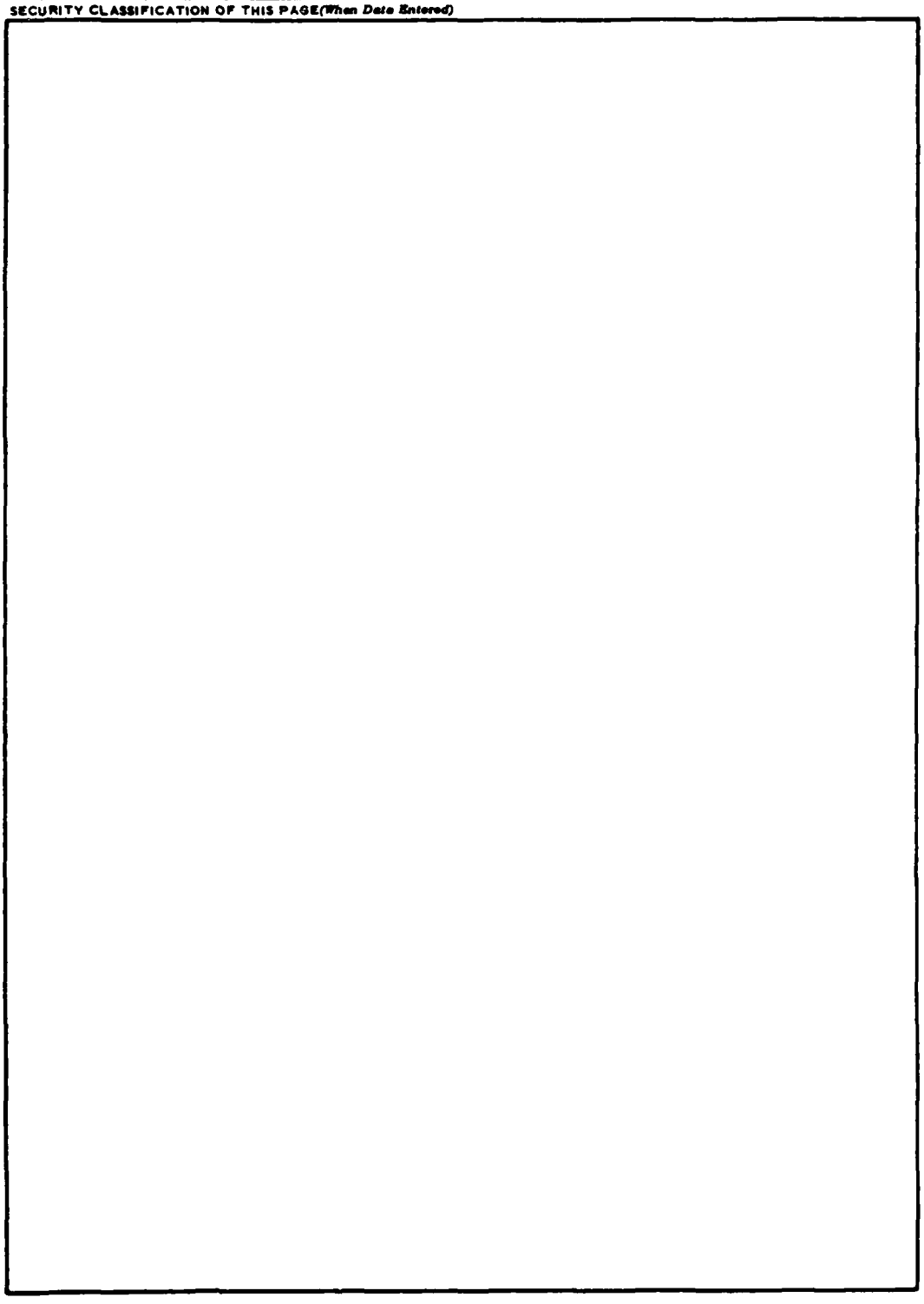

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Acknowledgments

This Agency extends its gratitude to those individuals listed in this report who took the time to share their knowledge and experience with tne author. Without their full cooperation, this document could not have been prepared in the two weeks allocated. Special thanks go to Mr. Charles W. Vail of Biosys Corp for providing the initial list of personal contacts and for guidance on content and direction.

Comments

Comments on the contents of this report are encouraged, and should be submitted to:

Commander and Director
US Army Facilities Engineering Support Agency
Fort Belvoir, Virginia 22060

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1.0 OBJECTIVE

To identify state-of-the-art methods for determining nonmerchantable forest biomass yields for use as fuel with emphasis on the Southeastern United States. This report has been prepared in support of Mr. Robert S. Baran (U.S. Army Construction Engineering Research Laboratory) and the Army's Biomass Energy Program.

2.0 METHODOLOGY

Telephone contacts were made with local, state, university and Federal officials to seek information about current or completed studies of forest biomass yield. Note was made of ongoing studies and publications were requested for final reports. Since only two weeks were available for this report, the first week was devoted to making contacts and obtaining literature. The second week was utilized to review/analyze literature and prepare findings. Not all requested literature is available at this writing; therefore, missing articles and items of interest obtained during telephone conversations will be listed in "Comments and Additional Information."

3.0 DISCUSSION

With the present day spiraling cost of conventional liquid and gaseous fuels, alternative energy sources are receiving intensive review. Forest biomass is a logical energy source. To consider major capital expenditures for conversion to a wood/biomass energy source, a necessary step is quantification of the resource. Today's forest resource base is extensively quantified and qualified in terms of merchantable products known in the present market. Most conventional log rules, yield tables and forest inventories have evolved through years of research and field experience and produce accurate and accepted measures of merchantable products.

To analyze what was formerly nonmerchantable material which may now be used as an energy source, industry and Government are involved in extensive research programs. It should be noted that the present day log rules evolved over a number of years and the use of a particular rule depends on local conditions, practice, experience, custom and personal bias. It would, therefore, seem to follow that measurement techniques of nonmerchantable or total biomass will evolve in the same fashion.

The organization, intensity and precision required of a timber cruise is based on the planned use of the information. It would also follow that the method of determining biomass yields would be contingent on the objective of the user. The following synopsis of current research and literature is, therefore, directed at providing a sampling of information for site specific, regional and national needs.

4.0 SITE SPECIFIC

The Southern Timber Project of the USDA Forest Service in Athens, GA has been working for the past ten years to develop yield tables and equations for predicting forest biomass weights and volumes. The basic approach was

to conduct random samples of objective species stands and obtain standard cruise data based on diameter breast height (DBH), tree height, and perhaps age. The sample plots were then felled and disected, and individual components (limbs, stem, pulpwood, saw timber, crown) quantified by weight. The weight measure may be by field scales or chipping of the material for weight on standard scales. A determination of moisture content and specific gravity would also be made. Simple linear regression equations were developed to predict the green and dry weight of tree components. The most reliable and easily used independent variable for these equations are DBH and tree height. Utilizing these equations with field test to verify accuracy, yield tables are developed for biomass.

Tables developed in this fashion have definite parameters for application such as: natural stand, closed stand, similiar age, taper rate, etc. There are numerous variables which can affect results of volume and weight predictions, but, when applied within the limits of the study, reliable site specific results can be obtained. A sampling of these papers is listed in the reference as numerics rather than alphanumerics (i.e., 8 vs 9-R).

Work is currently in progress for other species and species groups. Additional information can be obtained from Alexander Clark III at Southeastern Forest Experimental Station, Forest Sciences Laboratory, Carlton Street, Athens, GA 30602, phone (404) 546-2441.

Other approaches to site specific/species specific biomass research have been conducted. The papers are not available at this writing but will be mentioned in "Comments and Additional Information."

4.1 SITE SPECIFIC - SAWMILL RESIDUE

Research has been conducted on sawmill residue yields for numerous species. The methodology is much the same as species specific biomass studies except the process is carried to the mill where sawing residue is quantified and equations and yield tables developed. Available literature is in the references as numeric characters. Additional information on results for other species can be traced through the referenced authors.

5.0 REGIONAL

If a land manager was not interested in the biomass yield of a particular tree or small homogenous stand, his needs for the purpose of this report would be classified as regional. This would include the land manager of an Army post or national forest, etc. The land manager may have standard cruise information for his timber, but does not know how to translate this into volumes of biomass, both merchantable and nonmerchantable. The references 9-R, 10-R, 12-R, 16-R, 29-R and 30-R reflect work with regard to regional needs.

The basic approach has been to divide the species into recognized classifications such as hard hardwood, soft hardwood and pine. These may be further

subdivided such as bottomland hardwood, natural or plantation pine. Analysis is conducted in much the same way as species specific work. Results are tabulated, equations and yield tables developed and field tests conducted for verification. It appears that the tables developed from these regional methods would hold definite promise for the land manager trying to determine the biomass of his forest area for general management purposes.

One of the more manageable and flexible approaches to determining biomass for a region may be work being done by Alexander Clark and Richard Field at the Forestry Science Laboratory in Athens, GA. They are developing an ADP computer program for estimating the weight and volume of firewood, pulpwood, sawlogs and the total tree from standard cruise data using tree biomass equations. Data may be inputted from standard tree cruises such as fixed area plots, point sampling, strip cruising or 100 percent cruise where DBH and height are noted along with three species groups - pine, hard hardwood and soft hardwood. With this and other readily available information, biomass volumes can be outputted in numerous forms that provide the essential material required for land management decisions.

Another objective of this study is to develop easy to use hand computational tables for estimating total tree and tree component weight and volume, i.e., match systems presently available for field use in determining merchantable timber.

This study will be complete by December 1980. During discussion between Mr. Clark and this writer, Mr. Clark offered to make several runs of data provided by this office. The study, along with a sample computer run, is listed as 29-R in the references.

6.0 NATIONAL

The Northeast Experimental Station at Broomwall, PA is presently coordinating a "National Study of Biomass" for which a report is due by 1 Jan 81. Mr. Eric Worton of the station explained that each experimental station is responsible for gathering the information for their respective region and forwarding the results to the Northeast Station for compilation. Mr. Worton said that each station is developing individual techniques for determining total biomass. He did mention that a common approach exists whereby sample plots are taken for height, diameter and species and then plugged into regression equations. These results are then compared against actual field measurements.

The Rocky Mountain Forest Experimental Station at Ft Collins, CO is presently investigating the possibility of using satellite surveys to determine total tree crop biomass. No further information is available at this time as the study has not been initiated, but Gyde Monk is a point of contact.

The Rocky Mountain Station is also conducting a biomass literature search which should be finished by Oct 80.

7.0 COMMENTS AND ADDITIONAL INFORMATION

1. Dr. Vigerstad of the South Carolina Energy Research Inst., (803) 256-6400, has been actively involved in biomass work. Some of his observations are as follows:

a. Well managed forest stands will have less residue.

b. An integrated harvesting system is required in South Carolina to remove nonmerchantable biomass at a reasonable cost.

c. Since retrieval of nonmerchantable biomass is labor intensive, you must obtain greater than 8 tons per acre or be ready to pay pulpwood prices of $17-$20 per ton for biomass.

d. In South Carolina, if 20 ton/acre of biomass cannot be obtained from a thinning operation, it is not cost effective.

2. Dr. Wiant of West Virginia University, (304) 293-3411, has written an article on "Point Sampling for Biomass" that will be in a forthcoming article in the Journal of Forestry. Dr. Wiant has also written "Tables and Procedures for Estimating Weights of Appalachian Hardwoods."

3. Continental Can Corporation has utilized basal area calculations with factors to apply for tonnage that can be extrapolated for saw timber, pulpwood and residue.

4. Harry Hitchcock of TVA in Norris, TN, (615) 494-9800, has developed biomass equations for timber tracts near Ft Campbell, KY. His work has been mentioned by several other authors who say his methodology is promising.

5. Jim Brown, with the Forest Service in Missoula, MT, (406) 583-3474, has conducted line sampling for quantification of residue with regard to finer fuels in relation to fire control.

6. Harold Young at the University of Maine in Orono, ME, works with the Total Tree Institute and has conducted biomass work for the Northeast.

7. A paper by Larry Burkholder of Morbark Industries, Inc., (reference 32-0) presents some interesting observations from an equipment manufacturing firm's viewpoint.

8. "Estimation of Biomass Production and Removal" by Saucier and "Suggested Procedures for Measuring Tree Biomass and Reporting Tree Prediction Equations" by Clark point out problems with coordinating biomass research. Both authors reiterate the need to have standard nomenclature for forest weight and volume measurement so that biomass studies may be correlated to provide a meaningful data base (reference 14-0 and 28-0).

8.0 CONCLUSION/SUMMARY

The more important commercial species of the Southeastern U.S. have been studied and biomass equations and weight and volume yield tables developed. This information should provide a land manager with reliable site specific information.

Regional studies are utilizing site specific information to develop equations and yield tables for forest types. The regional studies will be subject to greater deviations than site specific work and will, therefore, take longer to gain acceptance, as modifications based on experience will be required. It is anticipated that several methodologies will evolve for regional work just as log rules developed for merchantable measuration. Regional information is available for the Southeastern U.S. that can provide a land manager with reliable general estimates of forest biomass from which nonmerchantable yield has or can be extrapolated.

Surveys of the national biomass base are currently in progress and these should refine previous guesstimates and provide a clearer picture of the national biomass resource base.

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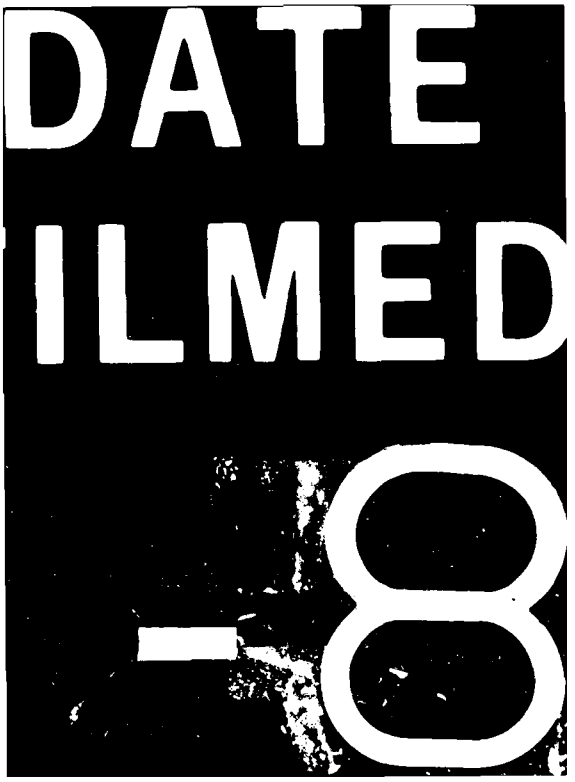
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